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Effect of autumn/spring nitrogen application date and level on dry matter production and nitrogen efficiency in perennial ryegrass swards

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The influence of autumn/spring N-application date and level on grass dry matter (DM) production in spring and on N uptake, recovery and efficiency were examined over 3 years (1998, 1999 and 2000, identified as Year 1, 2 and 3, respectively). Seven N-application dates were investigated in years 2 and 3 while four application dates were investigated in Year 1. The application dates were 21 October (T1), 11 November (T2), 2 December (T3), 23 December (T4), 12 January (T5), 3 February (T6) and 23 February (T7). Three N-application rates (kg N/ha) were used: 30 (N30), 60 (N60) and 90 (N90) plus a zero-N control (N0). Herbage DM yields were determined on: 18 March (H1) and 8 April (H2). Two herbage masses (HM) (40 mm above ground level) at initial N-application date were investigated: a high HM (HHM) of 500 kg DM/ha and a low HM (LHM) of 100 kg DM/ha. The HM at initial N-application date in Year 1 was HHM, in Year 2 LHM and in Year 3 both HHM and LHM. There was a significant effect of Year ($P<0.001$), HM ($P<0.001$), N-application date ($P<0.001$) and N level ($P<0.001$) on DM production at both H1 and H2. At H1 there was a significant interaction between N-application date and level for DM production. N-application date had a significant ($P<0.001$) effect on N recovery at both H1 and H2. The highest N recovery rate at the two harvest dates was at T5, while the lowest was at T1 and T2. At H1 and H2 there was a significant effect ($P<0.001$) of application date on response to applied N. The responses were 7.5, 8.0, 8.3, 12.0, 15.7, 7.3 and 5.6 (kg DM/kg N) (s.e. 1.88) for T1 to T7, respectively, at H1, while the corresponding values at H2 were 10.3, 8.7, 6.1, 15.2, 17.6,

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11.4 and 15.1 (s.e. 1.88). At H2 the response to applied N was 15.6, 11.5 and 9.1 (kg DM/kg N) for N30, N60 and N90, respectively ($P<0.05$). Regression analysis indicated that highest DM production was achieved with T5 for both H1 and H2 harvest dates, while the lowest responses were associated with T1, T2 and T3 application dates.

Keywords: Nitrogen; response; spring grass

Introduction

Dairy farming in Ireland is largely based on spring calving with the efficient conversion of grazed grass into milk (Dillon *et al.,* 1995). The objective of the system is to allow grazed grass to make up as large a proportion as possible of the total diet of the lactating dairy cow. Grass growth in Ireland is highly seasonal with peak grass growth rate occurring in May and June (Brereton, 1995). Daily growth rate can exceed 3 kg dry matter (DM)/ha per day for southern lowland conditions in the months from November to February (O'Donovan *et al.,* 2002). Previous studies have shown clearly the substantial benefits from allowing cows to pasture in early spring (MacCarthy, 1984; Sayers and Mayne, 2000; Dillon *et al.,* 2002). With decreasing financial returns from dairying, it is now more important than ever to exploit the potential of grazed grass during the entire grazing season and especially during the spring period (Donnellan *et al.,* 2002). Furthermore, the cost of grass silage has continued to increase and there is greater awareness of some of its limitations in terms of intake characteristics and nutritive value (Cushnahan and Gordon, 1995; Laidlaw and Mayne, 2000).

Date of autumn closing and of early spring-N application have been shown to be the two most important management factors influencing the supply of grass in spring (Carton *et al.,* 1989; Murphy, 1977). MacCarthy (1984) and Van Burg (1968) showed that the date in spring at which a given yield of grass is obtained could be brought forward by 3 weeks with N fertiliser if applied at the correct time. MacCarthy (1984) and Keane, Griffith and O'Reilly (1974) recommended that N should be applied 6 to 10 weeks before the start of grazing. Murphy (1977) suggested that the optimum date for applying N for early spring grass was some time in January for Johnstown Castle Research Centre. Stevens *et al*. (1989) suggested that the optimum date for Northern Ireland was in February.

The importance of autumn closing date on DM yield in the following spring has been highlighted in a number of studies (Carton *et al.,* 1989; Roche *et al.,* 1996; O'Donovan *et al.,* 2002). These results suggest that with spring-calving dairy cows, the last grazing rotation in autumn should start in late October. A total cessation of all grazing should take place by late November/early December. These studies have suggested a more planned approach to autumn grazing management to ensure a greater supply of grass the following spring with the possibility of achieving an earlier turnout date to pasture. Most previous studies which examined the influence of date of spring-N application on grass DM production were based on low autumn herbage mass levels (Van Burg, 1968; Murphy, 1977). Also with advancements in plant breeding, new grass cultivars have a higher spring DM yield potential than previously recommended cultivars (DAFRD, 2002).

One problem in applying N at a time of low grass growth is that loss of N may be high, either to the atmosphere and/or to drainage water. Leaching losses are generally high outside the normal growing season and so it is possible that N application in late autumn or early spring may exacerbate this loss. Therefore a series of experiments were carried out to investigate the effects of N-application date and level on spring grass DM production and nitrogen efficiency.

Materials and Methods

Location and site

The experiment was carried out at the Moorepark Research Centre, Fermoy, Co Cork (lat. 50°07′N, long. 08°16′W) on a permanent grassland site over 3 years (1998, 1999 and 2000), referred to as Year 1, 2 and 3, respectively. The soil type was a free-draining acid brown earth soil of sandy loam to loam in texture. The swards used were originally sown in 1995 with three different ryegrass cultivars, Condessa (late heading, tetraploid), Magella (intermediate heading, diploid) and Tyrone (late heading, diploid). The pasture had 80 to 85% perennial ryegrass (*Lolium perenne* L.) with some *Poa pratensis* and *Agrostis stolonifera*. Prior to the study in all years, all swards were part of a rotational grazing management system receiving 300 to 350 kg N/ha per year.

Design

The experimental design was a factorial combination of three N treatments and a zero N control, with seven application dates (only four in Year 1) and two harvest dates, which were arranged (2.0 m × 5.0 m plots) in a randomised block design with three replicates. Years which had either low or high grass covers were grouped together to incorporate a variable herbage mass (HM) in the analysis. Therefore the data from Year 1 and the high HM data from Year 3 were classified as HHM. The data from Year 2 and the low HM data in Year 3 were classified as LHM. The N-fertiliser treatments were imposed by applying urea (46% N) as a fine crystalline solid.

In Year 1, four N fertiliser application dates were used: 23 December (T4), 12 January (T5), 3 February (T6) and 23 February (T7). At each application date three N treatments (kg N/ha) were applied: 30 (N30), 60 (N60) and 90 (N90) as well as a zero N control. All plots were harvested twice in spring 18 March (H1) and 8 April (H2). The herbage mass at initial nitrogen application was 550 kg DM/ha (40 mm above ground level) and was identified as high herbage mass (HHM).

In Year 2, three further autumn N-application dates were added to the set used in Year 1; 21 October (T1), 11 November (T2), 2 December (T3). The same four nitrogen application rates and two harvest dates were used as in Year 1. One week prior to the commencement of the experiment (early October) the entire experimental area was harvested with an Agria mower (Agria-Werke, Moeckmuel, Germany) to 40 mm above ground level. The HM on 21 October prior to the first N application was 100 kg DM/ha, this was classified as low herbage mass (LHM).

The same experimental design was used in Year 3 as in Year 2, however, with both a HHM (500 kg DM/ha) and a LHM (100 kg DM/ha). Four weeks prior to the commencement of the experiment the entire site was harvested with an Agria mower to 40 mm above ground level. The LHM site was harvested again 1 week prior to the first nitrogen application in late October.

Herbage mass and chemical analysis

A 0.70-m wide cut was taken centrally along the length of the plot to 40 mm above ground level with an Agria mower (Agria-Werke, Moeckmuel, Germany). The cut herbage was collected and weighed, two samples were retained to determine DM content (dried at 85 °C for 24 h in a force draught oven). The mean DM content of the herbage was calculated by averaging the two DM figures. The two dried herbage samples were then bulked. The herbage was ground through a 0.8-mm screen and analysed for Kjeldahl nitrogen and for neutral detergent fibre (NDF) according to the methods described by Van Soest (1963).

Estimation of N uptake, recovery and efficiency

The uptake of N (kg N/ha) was calculated as

$$\frac{\text{DM production (kg DM/ha)} \times \text{Herbage crude protein concentration (g/kg)}}{6.25 \times 1000}$$

The proportion of applied N recovered was calculated for each application rate as

$$\frac{\text{N uptake (N30, N60 or N90) (kg N/ha)} - \text{N uptake at N0 (kg N/ha)}}{\text{N fertiliser rate (30, 60 or 90) (kg N/ha)}}$$

The efficiency of N applied was calculated as the DM response per kg of applied N and equals

$$\frac{\text{DM production (N30, N60 or N90)} - \text{DM production at (N0)}}{\text{N fertiliser rate (30, 60 or 90) (kg N/ha)}}$$

Statistical analysis

The herbage production, N uptake, recovery and efficiency data were analysed by analysis of variance using the statistical procedures of SAS (1991). The model used had fixed effects for year (3 levels), herbage mass (2 levels), N-application rate (4 levels), N-application date (7 levels) and the interactions of herbage mass × N-application date and herbage mass × N-application rate. All other interactions were non-significant in preliminary analyses.

Regression lines describing the response to the rate of N applied were fitted using a model with fixed effects for year, herbage mass, N-application date and the interaction of herbage mass × N-application date and N level and (N level)^2 as covariates. The interaction between the linear response to N level and application date was also included in the model.

Results

Weather

Table 1 shows the meteorological data (maximum and minimum air temperatures, soil temperatures at 100-mm depth and rainfall) for the months of October to April for the 3 years at the Moorepark site. The experimental sites were all within 1 km of the meteorological station. During the 3 years of the study, the months of November and December were the wettest (132 and 134 mm on average rainfall), while February (54 mm) and March (46 mm) had the lowest average rainfall. Mean soil temperatures (°C) over the 3 years was highest in October (11.7), November (8.5) and April (8.7), while January (5.4) had the lowest. Maximum air temperature followed the same trend as soil temperature. Mean minimum air temperature (°C) was lowest during the months of December (2.5) and January (2.2) while the highest minimum air temperature was recorded during October (7.7).

Table 1. Moorepark meteorological records for monthly rainfall, soil temperature at 100 mm, maximum and minimum air temperature for Year 1 (1998), 2 (1999) and 3 (2000)

Month	Year 1	Year 2	Year 3
		Rainfall (mm)	
October	93.1	137.1	72.7
November	195.0	130.7	70.3
December	116.5	138.9	145.1
January	146.8	95.5	51.5
February	24.8	44.4	92.4
March	70.3	39.7	28.0
April	137.6	85.2	51.2
		Soil temperature (°C)	
October	12.4	11.9	10.7
November	9.3	8.2	8.0
December	6.6	6.8	5.2
January	5.8	5.5	4.9
February	7.1	6.5	6.0
March	8.4	7.3	7.7
April	8.5	9.6	8.1
		Maximum air temperature (°C)	
October	14.9	14.9	14.3
November	11.7	10.6	11.2
December	9.8	10.3	8.9
January	8.9	9.4	8.1
February	10.6	10.1	10.3
March	11.9	11.1	11.7
April	11.8	13.1	11.3
		Minimum air temperature (°C)	
October	8.6	7.9	6.7
November	5.5	4.1	3.9
December	3.0	2.8	1.7
January	2.9	2.1	1.6
February	4.7	4.0	3.1
March	5.5	3.8	3.7
April	3.3	5.2	3.3

Herbage production and chemical composition

The effects of N-application date and level on DM production at both H1 and H2 are shown in Table 2. At H1 there was a significant effect of Year ($P<0.001$), HM ($P<0.001$), N-application date ($P<0.001$), N level ($P<0.001$), and N-application date by N level interaction ($P<0.001$). The significant effect of Year is expected because of the imposed HHM in Year 1, LHM in Year 2 and LHM and HHM in Year 3. Herbage DM yields (kg DM/ha) were 2311 and 1754 (s.e. 33.3) for the HHM and LHM, respectively. Maximum DM yield was achieved at T5 for N30 and N90 and at T4 for N60. DM was lowest at T1 and T7 based on mean values across N-application rates. The interaction between N-application date and level resulted from the lower DM production achieved on T4 and T7 with N90 when compared to N60.

At H2 there was a significant effect of Year ($P<0.001$), HM ($P<0.001$), application

Table 2. Effect of nitrogen application date and level on grass production (kg dry matter/ha) at two harvest dates during the 3 years of the study

Harvest date	Nitrogen level[1]	Nitrogen application date[2]							s.e.
		T1	T2	T3	T4	T5	T6	T7	
18 March (H1)	N0	1669	1727	1675	1603	1593	1639	1660	99.3
	N30	1913	2065	1913	1971	2132	1909	1887	99.3
	N60	2024	2115	2163	2433	2410	2111	1977	99.3
	N90	2316	2222	2270	2383	2721	2501	1914	98.7
8 April (H2)	N0	2423	2537	2659	2499	2502	2762	2608	122.8
	N30	2965	2898	3100	3181	3110	3214	3295	121.3
	N60	3070	3099	3301	3419	3609	3511	3456	121.3
	N90	3389	3249	3283	3516	3897	3673	3456	122.0

[1]Nitrogen levels were: N0 = zero-N control, N30 = 30 kg N/ha, N60 = 60 kg N/ha, N90 = 90 kg N/ha.
[2]Nitrogen application dates were: T1 = 21 October, T2 = 11 November, T3 = 12 December, T4 = 23 December, T5 = 12 January, T6 = 3 February and T7 = 23 February.

date ($P<0.001$) and N level ($P<0.001$), while the N-application date by HM interaction tended towards significance ($P=0.06$). Herbage DM yields (kg DM/ha) were 3441 and 2821 (s.e. 41.1) for the HHM and LHM, respectively. Maximum DM yields were achieved at T5 for N60 and N90, while at T7 for N30. DM production (averaged across N-application rate) generally increased as application date was delayed. The interaction between N-application date and HM was due to the small difference in DM yield between H1 and H2 for the late February N-application date (3385 *v*. 3022 kg DM/ha for T7); while there was a much larger difference in DM production at the earliest application date (3251 *v*. 2627 kg DM/ha for T1).

The influence of N-application date and level on crude protein (CP) concentration is shown in Table 3 for both H1 and H2. At H1 there was a significant effect of Year ($P<0.001$), HM ($P<0.01$), application date ($P<0.001$), N level ($P<0.001$), and an application date by N level interaction ($P<0.001$). The average herbage CP concentrations were 179.6, 167.3 and 194.4 (s.e. 1.33) g/kg in Years 1, 2 and 3, respectively. The CP concentration of the LHM was greater than the HHM (178.1 *v*. 182.6 g/kg; s.e. 1.05). The later application dates

Table 3. Effect of nitrogen application date and level on crude protein concentration (g/kg DM) at two harvest dates during the 3 years of the study

Harvest date	Nitrogen level[1]	Nitrogen application date[2]							s.e.
		T1	T2	T3	T4	T5	T6	T7	
18 March (H1)	N0	159.3	164.4	158.6	158.6	162.1	164.2	163.4	3.13
	N30	163.5	167.4	167.4	176.1	181.7	180.8	196.4	3.11
	N60	171.3	167.1	170.1	183.7	203.8	199.5	215.3	3.11
	N90	166.2	169.9	174.9	192.5	211.7	218.8	243.5	3.11
8 April (H2)	N0	139.0	138.9	137.3	141.7	138.5	147.8	137.0	4.82
	N30	139.4	140.9	142.7	147.6	151.8	149.5	162.4	4.75
	N60	143.1	147.2	144.1	149.7	160.4	165.8	176.8	4.77
	N90	142.5	143.9	146.8	161.9	168.7	180.6	190.4	4.79

[1,2] See footnotes to Table 2.

and the higher N-application rates yielded higher herbage CP than the earlier application dates and lower N-application rates. Nitrogen level had a much larger influence on herbage CP at the later application dates than at the earlier dates. At H2 the influence of Year, N-application date, N level and N-application date × N level on herbage CP were similar to that in H1. At H2, HM had an effect on CP of the herbage harvested.

At H1 both Year and HM had a significant effect (P<0.001) on NDF content of the herbage harvested. The NDF concentrations were 430.9, 364.9 and 402.3 (s.e. 2.39) g/kg in Years 1, 2 and 3. While the NDF concentration of the HHM and the LHM was 407.8 and 390.9 (s.e. 1.90) g/kg, respectively. Both Year and HM had a significant effect (P<0.001) on NDF concentration of the herbage harvested in H2. The NDF concentration was 454.7, 428.3 and 353.1 (s.e. 2.31) g/kg in Years 1, 2 and 3, respectively. The NDF concentration of the HHM and the LHM were 420.5 and 403.6 (s.e. 1.90) g/kg respectively, at H2.

Nitrogen uptake and recovery

Year, HM, N-application date, N level and the interaction between N-application date by N level all had significant effects on N uptake (P<0.001) at both H1 and H2. N uptake was 90, 30 and 61 kg/ha in Years 1, 2 and 3, respectively, at H1; while at H2 the corresponding values were 122, 43 and 71 kg/ha. The HHM captured significantly more N than the LHM in both H1 (68.2 *v*. 52.2 kg N/ha; P<0.001) and H2 (84.8 *v*. 72.2 kg N/ha; P<0.001). Figure 1 shows the interaction between N-application date and N level for both harvest dates on N uptake. The increase in N uptake at the higher N levels (N60 and N90) was much greater with the later application dates (T6 and T7) than at the earlier application dates (T1 and T2). N uptake increased from 57 (N0) to 80 kg/ha (N90) at T1, while at T7 it increased from 60 (N0) to 104 kg/ha (N90) at H2. The pattern of N uptake was similar with H1.

N-application date had a significant (P<0.001) effect on N recovery at both harvest dates. At H1 the N recovery rates were 0.21, 0.22, 0.26, 0.46, 0.61, 0.36 and 0.41 (s.e. 0.054) for T1 to T7, respectively, while at H2 the corresponding recovery rates were 0.19, 0.19, 0.23, 0.39, 0.53, 0.36 and 0.64 (s.e. 0.080) for T1 to T7. Year, HM and N level had no significant effect on N recovery at both harvest dates.

Herbage DM response and efficiency

At H1, there was a significant effect (P<0.001) of N-application date on

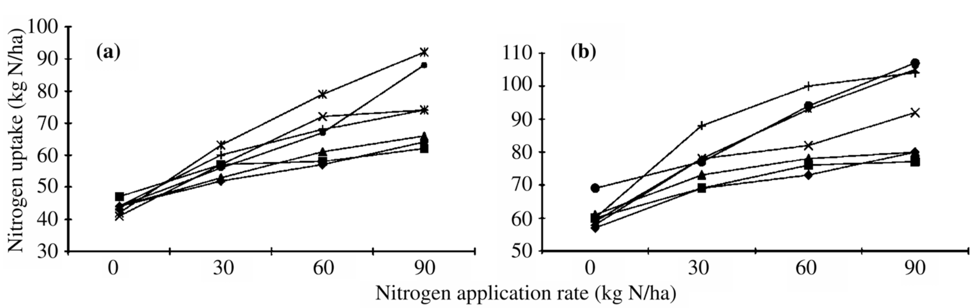

Figure 1: The effect of N-application date and level on N (kg/ha) uptake: (a) Harvest 1, (b) Harvest 2 (T1—◆—; T2—■—; T3—▲—; T4—×—; T5—+—; T6—●—; T7——).*

response to applied N. The responses (kg DM/kg N) were 7.5, 8.0, 8.3, 12.0, 15.7, 7.3 and 5.6 (s.e. 1.88) for T1 to T7, respectively. At H2 there was a significant (P<0.05) effect of Year, N-application date and N level on response to applied N. The responses (kg DM/kg N) were 5.8, 16.4 and 13.9 (s.e. 2.18) for Year 1, 2 and 3, respectively. The responses (kg DM/kg N) as influenced by application date were 10.3, 8.7, 6.1, 15.2, 17.6, 11.4 and 15.1 (s.e. 1.88) for T1 to T7, and for N30, N60 and N90 were 15.6, 11.5 and 9.1, respectively.

Using regression analysis the response in DM production to the application of N is shown in Figure 2. There was a significant slope interaction between N-application date and N level for DM response at both H1 (P<0.001) and H2 (P<0.05), therefore the responses were calculated for each application date separately. The results indicate that the largest DM responses were obtained at T5 with both H1 and H2.

Discussion

The application of N in early spring advances the date on which a grass yield suitable for grazing is obtained. This was demonstrated some 70 years ago (Blackman, 1936). Precise prediction of the date of N application for maximum yield of herbage as early as possible in spring is important for spring-calving grass-based dairy systems. However, precise prediction of the date will be difficult because of variation from year to year due to variation in soil and air temperatures (Stevens *et al.,* 1989). Date of N application will also depend on when grass is required and if it can be utilised as grazed grass. Applying N too early leads to a risk of losing N (leaching and denitrification). On the other hand, applying N too late leads to a loss of growing days. In recent years the importance of autumn closing date on herbage supply the following spring has been highlighted (Roche *et al.,* 1996; O'Donovan *et al.,* 2002). As a result it is now common practice on Irish dairy farms to start the final autumn grazing rotation in early October and grazing ceases by late November/early December. Therefore the paddocks rested in early October will have substantially greater herbage mass the following spring than paddocks rested in early December.

Herbage DM production

The mean daily values of soil temperature at 100-mm depth for the months of January, February and March were much greater than the corresponding values of 2.9, 3.0 and 5.0 °C for similar months in

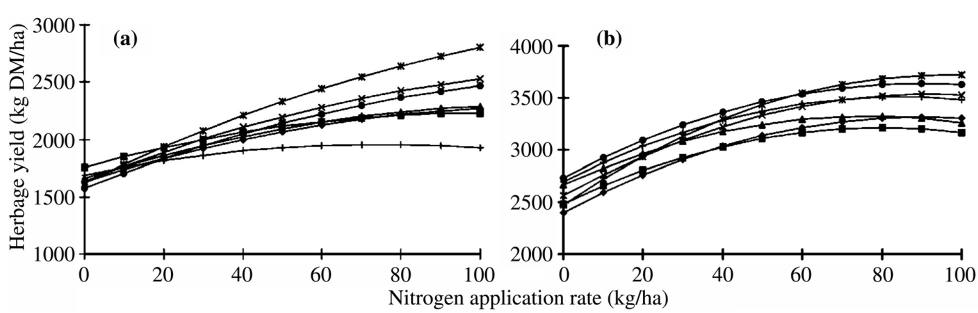

Figure 2: Regression lines relating dry matter (DM) yield to N-application date: (a) Harvest 1, (b) Harvest 2. (T1—◆—; T2—■—; T3—▲—; T4—×—; T5—+—; T6—●—; T7——).*

Northern Ireland (Stevans *et al.,* 1989). Jagtenberg (1970) suggested that N should be applied at the start of grass growth in spring. However, a correlation of the start of grass growth in spring with accumulated soil temperature has proven to be unreliable (Swift, 1983). In Northern Ireland the recommendation is to apply N in February (Stevans *et al.,* 1989). This study also concluded that using either soil (>5.5 °C) or air temperature (T-sum 200) predictive systems were no more successful at predicting the optimum application date to maximise yield of early spring grass than a simple date range. The absence of any advantage in applying nitrogen in the late autumn/early winter period in the present study agrees with previous results (Charles, England and Thomson, 1975; Murphy, 1977). Van Burg (1968) found that when N is applied in autumn or early winter, the yields obtained the following spring were lower than those achieved by the same N level applied in spring. The study also showed that N applications in late February result in lower DM production, especially when combined with an early harvest date. Murphy (1977) showed that there is considerable variation in the optimum time for applying N but concluded that the optimum date for the south east of Ireland was usually some time in January. The result of the present study indicates that the optimum date for the application of spring N is in early January for the south west of Ireland.

Herbage composition

The non-protein nitrogen (NPN) concentration in herbage depends on the level of fertiliser N applied and the nutrient status of the plant (Hegarty and Peterson, 1973). Between 70 and 90% of the N in herbage is in the form of protein; the remainder is NPN (peptides, amino acids, amines and inorganic nitrate). The findings that CP concentration of the herbage produced increased with N-application level and at later application dates and earlier harvest dates is similar to those previously observed (Wilman, 1980; Skinner and Allen, 1991).

Nitrogen uptake and recovery

The grass crop provides a major sink for N with a grass-based system (Whitehead, 1995). In general, the more N that is applied to the soil the more N that is taken up by the plant. The basic requirement for good N management is to attempt to balance flows into the mineral pool against the demand of the crop, avoiding deficiencies at times of growth and surpluses at other times. In relation to increasing N utilisation within the system, two concepts relating to the crop are important (Follet and Wilkinson, 1995), i.e. (1) N recovery (the N capture in the plant as a proportion of that applied), and (2) N use efficiency (the rate of increase in yield per unit of N applied). An examination of the recovery of applied N has been widely used as an index of the efficiency of applied fertiliser N (Cowling and Lockyer, 1970). The N recovery rates achieved with T1, T2 and T3 are lower than that published previously, but with T4, T5, T6 and T7 agree with previous results (McFeely and MacCarthy, 1981). Therefore the results indicate that the three earlier application dates were associated with greater losses of N, either by leaching or denitrification. Higher rainfall and lower soil temperature (conditions antagonistic to grass growth) increase the risk of N loss during this period (Table 1).

Nitrogen efficiency

In practical terms, most assessments of N requirement are based on plant response. Maximum yield is usually of little relevance because of the low returns in terms of DM yield per unit of N applied as the maximum is approached. An economic optimum response has been defined as the point at which herbage response falls to a designated level of herbage production. A response of 10 (Holmes, 1989) or 7.5 (Thomas, Reeve and Fisher, 1991) kg DM/kg N are often used as the criterion.

Murphy (1977) examined three rates of N application (26, 51 and 103 kg N/ha), with application dates at 2-week intervals from 22 December to 24 March and harvest dates of 24 March and 14 April. The averaged response was 2.9, 7.0 and 3.8 kg DM/kg N for the 26, 51 and 103 kg N/ha, respectively, at the March harvest and the corresponding values were 15.8, 11.3 and 9.7 kg DM/kg N at the April harvest. McFeely and MacCarthy (1981) found N-use efficiency varied from year to year and ranged from 8.7 kg DM/kg N in 1975 to 14.7 kg DM/kg N in 1972. MacCarthy (1984) found the 6-year average N efficiency was 5.3 kg DM/kg N in the late January to early March period. During the period after the first grazing (early to late March) N efficiency was lower (4.0 kg DM/kg N). The DM response improved considerably during subsequent periods and on average exceeded 10 kg DM/kg N. The response levels reported in this study are higher than previously reported but are consistent with those reported by McFeely and MacCarthy (1981). The optimum level of N used for early grass will depend on grass demand (stocking rate) and milk: nitrogen price ratio. For most intensive dairy farms in Ireland the optimum level of N to apply is between 30 and 60 kg N/ha for early spring grass.

Conclusion

For the site studied the optimum date to apply N for spring grass is mid-January when herbage is required in mid-March. For herbage required in early-April the optimum date to apply N could be delayed to early February. The application of N in late autumn/early winter is not recommended for spring grass production due to lower efficiency of N utilisation and possibly greater losses to the environment.

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